STUDENTS MANUAL

OF

URINARY ANALYSIS

MITCHELL

STUDENTS' MANUAL

OF

URINARY ANALYSIS

CHEMICAL AND MICROSCOPICAL.

COMPILED, TRANSLATED AND ABRIDGED FROM THE MOST RECENT FRENCH AUTHORITIES.

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WITH A PREFACE BY

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PREFACE.

HAVING carefully followed the work of Dr. MITCHELL in arranging and condensing the matter contained in the following pages, I feel sure that the student will find it of practical value in his laboratory work, and the busy physician may be saved valuable time by its use.

In it the practitioner will find the essentials for urinalysis, and be able to accomplish thereby what is often left undone for want of a systematic method in such available form as this.

CHAS. ADAMS, M. D.

THE following authorities have been consulted in the compilation of this Manual :

BOUCHARDAT, MEHU, DELEFOSSE,	From the French.
BEALE, HARLEY,	From the English.
FLINT, ROBERTS,	From the American.

C. M.

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URINARY ANALYSIS,

CHEMICAL AND MICROSCOPICAL.

PART I.

CLINICAL EXAMINATION OF URINE.

Examination.—Urine should be examined when four or five hours old. About 200 cubic centimeters* is the quantity requisite for ordinary examination.

Color.—Normal urine has a yellowish, straw color.

The urine in fevers is dark; in anaemic patients, pale.

Odor.—Normal urine has an odor distinctively its own, called "urinous."

Saccharine urine has an alcoholic odor. In some diseases of the kidneys the urine is *gangrenous* in odor.

Appearance.—Urine has not the same appearance when freshly voided as when cold. Hence, allow the liquid to stand a few hours before beginning the analysis.

NOTE.—Urine of acid reaction, having a specific gravity of 1025 or thereabouts, becomes turbid on cooling.

[*About 6 ounces.—TRANS.]

The substances causing turbidity in normal urine are composed of two layers: the upper, near the surface of the liquid, consisting of pure mucus; the lower, near the bottom, consisting of mucus and crystalline sediments.

Deposits.—For the microscopical examination of deposits, an instrument magnifying 250 diameters is quite sufficient for ordinary purposes. To detect spermatozoa, an instrument magnifying 400 diameters is necessary.

Reaction.—Normal urine colors blue litmus paper *slightly* red, i. e., is slightly acid in reaction.

If blue paper is turned markedly red, the urine is *decidedly acid.*

If red litmus is turned blue, the urine is *alkaline*

If urine changes the color of neither the red nor the blue paper, it is *neutral.*

Variations in Reaction.—Normal urine after a meal may be neutral or slightly alkaline.

Determination of Constituents by Reaction.—Alkaline urine turns red litmus paper blue. If this blue color on exposure to the air fades, and the paper again acquires its red color, the carbonate of ammonium is the alkaline constituent; if the paper retains its blue color, the carbonate or phosphate of sodium causes the alkalinity.

Specific Gravity.—To determine the specific gravity of urine, procure an urinometer and a beaker. [The urinometers commonly sold in this country are graduated from zero to fifty; zero representing the depth to which the instrument sinks in water—eighteen in healthy urine, thirty and upwards in saccharine urine. It is fashionable to denominate these numbers 1000, 1018, 1030, after the French.] Pour the urine *very gently* into the beaker, avoiding the formation of any foam upon the surface. Dip the urinometer *also gently* into the fluid until it no longer sinks of its own accord. The number on the scale corresponding to the level of the liquid represents the specific gravity of the urine. Thus, if the urinometer sinks to the number 20 on the scale, we call the specific gravity of the urine at 15° Cent., (60° Fahr.), 1020. If the temperature be other than 15° Centigrade, consult Bouchardat's Table of Corrections:

CENTIGRADE SCALE.

NON-SACCHARINE URINE.				SACCHARINE URINE.			
Subtract.		Add.		Subtract.		Add.	
0°	0.9	15°	0.0	0°	1.3	15°	0.0
1	0.9	16	0.1	1	1.3	16	0.2
2	0.9	17	0.2	2	1.3	17	0.4
3	0.9	18	0.3	3	1.3	18	0.6
4	0.9	19	0.5	4	1.3	19	0.8
5	0.9	20	0.9	5	1.3	20	1.0
6	0.8	21	0.9	6	1.2	21	1.2
7	0.8	22	1.1	7	1.1	22	1.4
8	0.7	23	1.3	8	1.0	23	1.6
9	0.6	24	1.5	9	0.9	24	1.9
10	0.5	25	1.7	10	0.8	25	2.2
11	0.4	26	2.1	11	0.7	26	2.5
12	0.3	27	2.3	12	0.6	27	2.8
13	0.2	28	2.5	13	0.4	28	3.1
14	0.1	29	2.7	14	0.2	29	3.4
15	0.0	30	3.0	15	0.0	30	3.7
Subtract.		Add.		Subtract.		Add.	

CORRECTIONS IN FAHRENHEIT SCALE.—(FLINT.)

Temp.	Add.	Temp.	Add.	Temp.	Add.
60°	0.00	69°	0.80	78°	1.70
61	0.08	70	0.90	79	1.80
62	0.16	71	1.00	80	1.90
63	0.24	72	1.10	81	2.00
64	0.32	73	1.20	82	2.10
65	0.40	74	1.30	83	2.20
66	0.50	75	1.40	84	2.30
67	0.60	76	1.50	85	2.40
68	0.70	77	1.60		

For example, suppose the specific gravity of a sample of urine has been found to be 1025; if its temperature be 75° F., add 1.40 to this, and we have 1026.40 as the true specific gravity.

Determination of Solid Matters contained in the Urine.—Find the specific gravity, as above. Multiply the last two figures by 2.2, this will give the number of grammes of solid matters in 1000 grammes of urine.

For instance, if the specific gravity of a specimen of urine be 1030, 30 x 2.2, or 66, will represent the number of grammes of solid matter in 1000 grammes of urine.

DETECTION OF ABNORMAL PRINCIPLES IN THE URINE.

Albumen.—Specific gravity generally low. The best tests for the presence of albumen in the urine are heat and nitric acid, used simultaneously.

(*a*). If the urine is acid in reaction, heat a portion of it in a test tube; if a white precipitate appear, add nitric acid; if the precipitate is not dissolved by the acid, the urine contains albumen.

(*b*) If the urine is alkaline, first add to it five or six drops of acetic acid, then apply heat, and afterwards nitric acid.

Ten or fifteen drops of nitric acid should be employed in making this test, and 4 or 5 grammes* of urine.

CAUTIONS IN TESTING FOR ALBUMEN.

A. The precipitate appearing may consist of urates; if so, *boiling* the urine will cause the precipitate to clear up, and the urine acquires a reddish color.

B. The precipitate may consist of the nitrate of urea; but in this case it forms slowly, and in the shape of fine crystals.

C. In urine containing a large quantity of albumen, no precipitate will form when only *two or three drops* of nitric acid are added, but only when ten or fifteen are used.

D. The precipitate caused by heating may consist of phosphates, but in this case adding nitric acid *will dissolve* the precipitate.

*About a tea-spoonful.

QUANTITATIVE ESTIMATE OF ALBUMEN.

The method of Mehu is the simplest, and is founded on the property which carbolic acid has of precipitating albumen.

(*a*) Take 100 grammes of urine, and add
(*b*) 4–5 drops acetic acid;
(*c*) 2 cubic centimeters non-concentrated nitric acid;
(*d*) 10 " " of the following solution:

$\left\{\begin{array}{l}\text{1 part (crystals) carbolic acid;}\\ \text{1 part acetic acid;}\\ \text{2 parts alcohol.}\end{array}\right.$

Mix the solution thus formed by (*b*), (*c*) and (*d*), well with the urine, and the albumen will be precipitated; filter; wash the precipitate with water containing one per cent. of carbolic acid.

Dry and weigh.

A rough method of determining the quantity of albumen contained in a given amount of urine, is given by Flint:

"Add acetic acid; boil, and allow the flaky precipitate to settle; its proportion may then be estimated as one-eighth, one-fourth," etc.

Sugar.—Specific gravity generally high.

(*a*) If the urine also contains albumen, use Bouchardat's test for sugar in the urine.

Take 50 cubic centimeters (ten teaspoonfuls) of urine, and add to it a heaping teaspoonful of slaked lime. Boil over an alcohol lamp. If there is sugar in the urine, it acquires a yellow or dusky hue, according to the quantity of sugar present. (If little sugar, a brownish hue.)

(*b*) If the urine contain no albumen:

Take 4 grammes of urine;
Add 2 " of a solution of potassium hydrate.

Mix, and add a drop of a solution of sulphate of copper. Boil, and a yellow or red precipitate is formed. (Trommer's test.)

(*c*) Bottger's test—for urine containing no albumen:

Add to the urine a little caustic potash (potassium hydrate), and some sub-nitrate of bismuth. Boil, and there appears a black precipitate, if sugar be present.

(*d*) Hager's formula for "Fehling's test liquid:"

34.65 grammes copper sulphate (pure), in solution in 200 cubic centimetres of water.

150 grammes of neutral tartrate of potassium in 500 cubic centimeters of sodium hydrate in solution.

Add 100 grammes of pure glycerine, and complete the amount to a litre with distilled water.

This preparation is comparatively stable, and preserves its qualities almost indefinitely. To test the urine with it, first gently boil some of the solution; then add half its bulk of the suspected urine, and again boil. A red or yellowish-red precipitate indicates sugar, and 20 cubic centimetres of the test liquid corresponds to 0.1 gramme of sugar.

NOTE.—A *whitish* precipitate indicates *phosphates*.

A simple quantitative method for determining sugar, is that of Roberts:

(*a*) Four ounces of urine in a 12 oz. vial, with a lump of German (condensed) yeast of the size of a small walnut.

(*b*) This to be *loosely* corked, and fermented in a warm place.

(*c*) A companion vial filled with urine from the same patient—say 3 oz.,—is *tightly* corked and placed beside the fermenting vial.

(*d*) Let both stand twenty-two hours, until fermentation is over; then remove to a cool place, and let them stand two hours. Next, take the specific gravity of both specimens; the difference between the two specific gravities indicates the amount of sugar to the fluid ounce of urine. Thus, if the fermented urine have a density of 1005, and the unfermented one of 1035, the urine contains 30 grs. to the oz. Consider, always, the amount of urine passed in a day; an ounce of urine may contain 20 grains on one day, and 40 on the next; but in the latter case a less amount of urine may have been passed during the day.

Bile.—Urine containing bile is dark, and often brown, red, or green. Its reaction is neutral or alkaline, and it foams when shaken.

Test.—(*a*) Take a test tube, made small at its lower extremity; pour in the urine, down the sides of the tube, very

gently. Make a mixture of nitric and sulphuric acids, and pour this also gently down the sides of the test tube into the urine.

If bile be present in the urine, a green zone will form at the line of demarcation of the urine and the mixture of acids.

(*b*) Nitrous acid will give the same results, if used instead of the mixture.

(*c*) Pettenkofer's test, and the color-test with nitroso-nitric acid, are also useful.

Blood.—Mix equal volumes of spirits of turpentine and tincture of guaiac; shake thoroughly. Let an equal volume of urine trickle down the sides of the test tube. Allow the mixture to stand a few moments. If blood be present, a blue—often indigo-blue—will appear at the line of demarcation between the urine and the emulsion; this blue color does not appear when normal urine is used; it is a special indication of the presence of blood in the urine.

Ammonia.—To test the urine for ammonia, in however small quantities, prepare a solution of the double iodide of mercury and potassium, and add to it potassium hydrate.

Partially fill another test tube with urine; add 1-10 part of sulphuric acid to this.

Let it stand 10 or 12 hours, and add a drop of the double iodide solution.

If ammonia be present in the urine, a precipitate will be formed.

PART II.

DEPOSITS.

Chemical reactions are *useful* in analyzing deposits, but the microscope is indispensable in identifying them.

The following is a table of urinary deposits according to the reaction of the urine:

Acid Reaction:	Amorphous bodies.	Acid urate of sodium.
	Crystalline, "	Uric acid, Cystine.

Neutral Reaction:
- Oxalate of calcium,
- Phosphate of calcium,
- " of magnesium.

Alkaline Reaction:
- *Amorphous bodies,*
  - *Urates* (if strongly alkaline),
  - *Calcium phosphate,*
- *Crystalline bodies,*
  - *Oxalate of calcium,*
  - *Acid urate of ammonium,*
  - *Ammonio-magnesium phosphate.*

Deposits occurring under all these reactions — organic bodies.

(1) Mucus.
(2) Pus.
(3) Blood globules.
(4) Tube casts.
(5) Epithelial cells.
(6) Fungi.
(7) Vibrions.
(8) Spermatozoa.
(9) Cancerous matter.

TESTS.

(I) *Acid urate of sodium.*

Urine acid in reaction.

Heat clears up deposit.

Potassium hydrate likewise clears it up.

(II) *Uric acid.*

Urine acid in reaction.

Place a few of the crystals on porcelain; add a little nitric acid; heat gently; add ammonia. Magnificent red color indicates uric acid.

(III) *Cystine.*

Urine acid in reaction.

Deposit soluble in ammonia indicates cystine; uric acid is not soluble in ammonia.

(IV) *Urates.*

Urine strongly alkaline.

Heat clears up deposit.
Murexid test, with nitric acid and ammonia, as in case of uric acid.

(V) *Phosphate of calcium.*
Urine alkaline (or neutral.)
Deposit not cleared up by heat.
Deposit not cleared up by potassium hydrate.
Soluble in nitric acid without effervescence.

(VI) *Oxalate of calcium.*
Urine alkaline (or neutral).
Insoluble in acetic acid.
(Phosphate of calcium *soluble* in acetic acid.)

(VII) *Acid urate of ammonium.*
Urine *alkaline.*
Treated with an acid, gives same reaction as uric acid.
Treated with an alkali, it gives off ammonia.

(VIII) *Ammonio-magnesium phosphate.*
Urine *alkaline* (or neutral)
Soluble in acetic acid.
Insoluble in potassium hydrate.
Insoluble when heated.

NOTE.—*Phosphates* existing as deposits in the urine, may be recognized by the following test:
Dilute deposit with distilled water; add nitric acid and a little of ammonium molybdate; heat, and a yellow color is produced.

(IX) *Mucus.*
Urine *acid, alkaline, or neutral.*
Acetic acid renders turbid, or augments already existing turbidity.
Hydrochloric acid causes this turbidity to disappear (if there is no albumen present).
Nitric acid *dilute* dissolves mucus, but coagulates albumen.

(X) *Pus.*
Urine sometimes acid, but generally alkaline.
Urine, white, opaline, milky, *clearing* on standing.

Potassium hydrate makes the deposit *markedly* ropy, so that it cannot be poured off in drops, and renders it *transparent.*

NOTE.—If the urine, on addition of potassium hydrate, becomes transparent, but *not* ropy, phosphates are present.
If the urine, on addition of potassium hydrate, becomes ropy and *not* transparent, both pus and phosphates are probably present.

[For other distinctions see Part IV, "Microscopical Examination of Urine."]

PART III.

ANALYSIS OF URINARY CALCULI.

The chemical elements in calculi are the same as those in deposits.

Method of procedure.

Reduce calculus to powder.

Place this upon platinum foil.

Heat in the flame of an alcohol lamp to a red heat.

If the heating is accompanied *with a flame,* the calculus contains either (*a*) fatty matters, (*b*) cholesterine, or (*c*) cystine.

Fatty matter and cholesterine are soluble in ether.

Cystine in ammonia.

Moreover, the odor of cystine is nauseous, and its flame is bluish-green in color.

If the heating is *unaccompanied by flame,* the calculus consists of one or more of the following:

Uric acid.	Urate of magnesium.
Urate of ammonium.	Oxalate of calcium.
Xanthine.	Phosphate of calcium.
Fibrine.	Ammonio-magnesium phosphate.
Urate of sodium.	Carbonate of calcium.
" " calcium.	

NOTE.—The phosphate of calcium, when mixed with ammonio-magnesium phosphate, is fusible.

We distinguish, in the case of the latter, those which (*a*) leave *no residue* upon calcining; (*b*) those which leave a *slight* residue; and (*c*) those which leave *considerable* residue

Those which leave *no* residue, are

Uric acid.

Urate of ammonium.

Xanthine.

Fibrine.

We distinguish the two former of these from the two latter by the Murexid test (i. e., nitric acid and ammonia), which detects uric acid and the urate of ammonium, but not xanthine and fibrine.

Uric acid is distinguished from the urate of ammonium in that *no ammonia* is set free when the Murexid test is applied.

Xanthine is distinguished from fibrine by its solubility in potassium carbonate.

Fibrine is soluble in caustic potash (potassium hydrate); has an odor of burnt horn; is precipitated by the ferrocyanide of potassium.

Those calculi which leave a *slight* residue on incineration, consist of the urates of sodium, calcium and magnesium.

We distinguish them as follows:

From the oxalates and phosphates, by the Murexid test.

From one another:

Urate of Sodium

Leaves a trace of melted matter on the foil.

Urate of Calcium.

Dissolved in an acid, and treated with the oxalate of ammonium, yields crystals of the oxalate of calcium. (See Part IV.)

Urate of Magnesium,

Dissolves with effervescence in sulphuric acid.

Gives a precipitate of the ammonio-magnesium phosphate, with ammoniated phosphate of sodium.

If the calculus leaves a *considerable* residue after incineration, it consists of either

Calcium oxalate,

Calcium phosphate,

Or the ammonio-magnesium phosphate.

The method of distinguishing these from one another, is as follows:

The *oxalate of calcium* effervesces when a drop of acid is added to the residue; it is, moreover, insoluble in acetic acid.

The phosphate of calcium and the ammonio-magnesium phosphate do not effervesce on the addition of an acid.

The phosphate of calcium, if treated with an acid and the oxalate of ammonium, gives a precipitate of the oxalate of calcium.

[See Part IV for microscopical differences.]

Sometimes the calculus consists of the carbonate of calcium, which is recognized by adding an acid to it before heating on the platinum foil. An effervescence indicates a carbonate. The calcium is recognized as before, i.e., dissolved in an acid, and treated with oxalate of ammonium, it yields crystals of the oxalate of calcium.

PART IV.

MICROSCOPICAL EXAMINATION OF THE URINE.

I. ACID REACTION.

(1) *Acid urate of sodium* (amorphous).

Appearance: agglomeration of little grains.

Heat gently—they dissolve.

Add a drop of hydrochloric acid, and there appear uric acid crystals.

(2) *Uric acid* (crystalline).

Clear crystals, having the form of lozenges and square prisms.

(If indistinct, dissolve with hydrochloric acid, and allow to crystallize.)

II. ALKALINE REACTION.

Phosphate of calcium (amorphous or crystalline).

Dissolve in nitric acid; add ammonia.

Granules indicate calcium phosphate.

Penniform crystals, ammonio-magnesium phosphate.

Oxalate of calcium (crystalline).

Appearance: that of letter envelopes.

(Take specimens from all layers of the urine.)

Acid urate of ammonium (crystalline).

Appearance: tiny, opaque spheres like stars, or else trimmed with points appearing like needles.

Add a drop of hydrochloric acid and these form crystals of uric acid.

Ammonio-magnesium phosphate (crystalline).

Appearance: three-sided prisms, with beveled ends.

III. ANY REACTION.

Mucus.—Slightly granular cells, somewhat larger than blood globules, outlined in a transparent substance enclosing several granular points. Often among them are to be found epithelial cells from the bladder, or some other part of the urinary mucous membrane.

Pus.—Globules somewhat larger than those of blood.

Treat with acetic acid, the nuclei will appcar.

Treat with ammonia, the nuclei will disappear, and the pus then assumes a viscous consistency.

Mucus does not have this viscidity.

Blood corpuscles.—Red corpuscles more numerous.

Seen on their surface, they resemble concave discs.

Seen from their side, they resemble bi-concave lentils.

White corpuscles less numerous (1 to 355 of the red).

Pale, granular, spherical, with their rims gently indented.

When treated with acetic acid, they become transparent, larger, and display in their centre two or three little nuclei. Globules which do not, when thus treated, display nuclei, are called pyoid globules.

Tube casts.—The following may be found in urine:

1. Mucous.
2. Fibrinous.
3. Epithelial.
4. Hyalin or Colloid.
5. Amyloid.

Generally, the casts met with in the field of the micro-

scope are straight, and come from the straight part of the tubuli of the kidney; sometimes, however, they are curvilinear, coming from the curved portions.

If the epithelial cells are cylindrical, the cast generally comes from the medullary portion of the kidney.

If pavement epithelium be found, it will come from the convoluted portions of the urinary tubules.

Mucous Casts.—These are simple casts without epithelial cells, with difficulty distinguished from urine, being only a little more refractive. Composed of mucine, they have no utility in a diagnostic point of view. They can be rendered more distinct by coloring them with an ammoniacal solution of carmine.

Fibrinous Casts are to be met with in cases of hemorrhage from the kidneys.

They have all the characters, chemical and microscopical, of fibrine; they are pale-yellowish; are covered with scattered epithelial cells.

Epithelial Casts are the products of desquamation of the straight part of the urinary tubules; should be looked for among *the deposits;* are often very difficult to find.

The epithelial cells which cover them are nearly normal. Are met with in acute nephritis, accompanied by epithelial cells and uric acid deposit. Are generally rectilinear.

Are to be met with, also, in normal conditions of the body, when the kidneys are over-excited.

[The epithelial cells may have undergone granular, then fatty degeneration.]

Albuminous urine contains them generally among its deposits.

Hyalin or Colloid Casts are met with, also, in albuminous urine; are more often curvilinear than rectilinear; have their extremities cut like glass; their surface generally polished. They contain cracks and roughnesses, due to blood globules and epithelial cells. As their name indicates, they are transparent, like glass.

Amyloid Casts are a metamorphic form of the preceding. Are distinguished from them by their great resistance to

chemical reactions. A little of an aqueous solution of iodine added to them, causes a yellowish or red tint within the cast.

A couple of drops of sulphuric acid change this tint to violet (rarely blue).

The majority of tube casts are outlined more distinctly when treated with acetic acid. Blood casts and calcareous casts are similar to those mentioned previously.

Epithelial Cells often appear in the urine; sometimes from the kidneys, often from the ureters and the bladder, from the canal of the urethra, and, in the female, from the vagina. They are more numerous in saccharine urine. It is necessary, in examining them, to note their quantity, form and changes.

1. *Epithelial Cells from the Kidney.*

These are usually of glandular or cylindrical epithelium, with one or two nuclei.

2. *Epithelial Cells from the Ureters or Bladder.*

The epithelium, from the ureters and bladder, is mixed, consisting of four varieties of epithelial cells—the pavement variety dominating generally. We have, then:

(*a*) Nuclei cells, having all the characteristics of those of epithelial cells, but free, instead of being in the centre of a cell.

(*b*) Spherical cells, which, by mutual compression, may become polyedral.

(*c*) Prismatic cells, with oval nuclei, provided with one or two nucleoli.

In the prostate the cells are prismatic, and provided with vibrating cilia.

(*d*) Pavement cells, already described.

3. Cells from the *Canal of the Urethra.*

The epithelium is of the pavement variety, in the fossa navicularis; then tends to assume a prismatic or cylindrical form in the muscular and prostatic portions.

The mucous membrane in the urethra of the female is lined with pavement epithelium also; likewise that of the vagina.

Champignons.—The fungi met with in the urine may be due to acid, ammoniacal or alcoholic fermentation. The first are found in normal urine which becomes acid on standing. These are cells, sometimes isolated, sometimes joined end to end, in linear series; they are to be found among the deposits of the urate of sodium and uric acid.

The second are found in the decomposition of urea into carbonate of ammonium, and are of the group of Torulaceae.

The third are found in diabetic urine. These are cells round or oval, and containing sometimes one or two very small corpuscles. They are also to be met with in non-saccharine urine.

Vibrions.—These have a linear form, are convoluted, and possessed of a Brownian movement.

Spermatozoa.—These are filiform, mobile bodies, composed of one tolerably large part, somewhat flattened, which is called the head, or disc, and a long appendix called the tail, which ends in a point. Their length is 0.05 millimetres, and they have a very lively movement when recently voided. [To be sought for in the morning in the deposit, with a microscope magnifying from 400–500 diameters.]

CANCER CELLS.

Cancer Cells.—These are variable in form and size, and contain more or less germinal matter.

They must not be confounded with the epithelium of the ureter or the cells of the bladder.

PART V.

NORMAL CONSTITUENTS OF THE URINE.

Urea.	Phosphates.
Uric acid.	Sulphates.
Chloride of sodium.	Coloring matter.

UREA.

Urea is never found as a sediment, since it is soluble in

water; therefore the only method of estimating it is by an analysis. Methods of determining the presence of urea are somewhat difficult and complex, and the student is referred to the larger manuals for them.

The best method is that of Esbach, or of Liebig.

In the former method, the urea is decomposed by the hypobromite of sodium. [See Appendix.]

URIC ACID.

To determine the quantity of uric acid, take 200 cubic centimetres of urine, and add to it 20 cubic centimeters of hydrochloric acid.

Allow the mixture to stand thirty hours in a cool place.

Crystals form; purify these by dissolving them in hot water containing a little caustic potash (potassium hydrate) in solution, and re-precipitate them with nitric acid.

Place the crystals then upon a small filter, dry and weigh them.

The amount found on weighing is, of course, the amount of uric acid contained in 200 c. c. of urine.

Multiply this amount by the amount of urine passed in 24 hours; divide the product by 200, and the result will be the amount of uric acid passed in 24 hours.

SODIUM CHLORIDE.

The minimum quantity of sodium chloride, normally present in the urine of 24 hours, is from 8 to 10 grammes.

Test.—Add nitric acid in excess; next add nitrate of silver, and a white, curdy precipitate of the chloride of silver is obtained.

Quantitative Estimation.—To ascertain the *quantity* of the chloride of sodium in the urine: take 10 cubic centimeters of filtered urine; pour it into a platinum capsule; evaporate gently, and, before it is all evaporated, add a gramme of the nitrate of potassium (crystals); calcine the mixture until the organic matters are completely charred, and the residue is *pale-colored.*

Dissolve this residue in water acidulated with nitric acid in excess, and into the solution pour a solution of the nitrate

of silver; there is formed a white precipitate of the chloride of silver, which is to be *washed* and *weighed* after it has settled. 100 grammes of silver chloride correspond to 24.75 grammes of chlorine, and 40.75 grammes of sodium chloride.

Consequently, proportion will enable us to calculate the amount of common salt corresponding to any weight of silver chloride found. If albumen be present, it should be first precipitated and removed from the urine before the above test is employed.

PHOSPHATES.

Phosphoric acid is found in the urine, not free, but in combination with potassium and sodium (alkaline phosphates); also with calcium and magnesium (earthy phosphates).

The earthy phosphates precipitate themselves if the urine be alkaline; otherwise, add ammonia to cause them to appear. Filter the solution, and add carbonate of ammonium and sulphate of magnesium to the clear filtrate; then there appears a second precipitate of the ammonio-magnesium phosphate. The sodium and potassium phosphates lose their phosphoric acid, which unites with the ammonium and magnesium, forming the above mentioned ammonio-magnesium phosphate; while the carbonic acid of the ammonium carbonate, uniting with the sodium, forms carbonate of sodium, which, being soluble, remains invisible; also, the sulphuric acid of the magnesium sulphate, uniting with the potassium, forms potassium sulphate, also soluble and invisible.

To determine the total quantity of *phosphates* present in the urine: collect, dry and weigh the two precipitates, using 50 cubic centimetres of urine.

NOTE.—It is well to let the precipitate of the earthy phosphates stand 24 hours before filtering.

The result found is, of course, the amount of phosphates contained in 50 cubic centimetres of urine.

To estimate the amount of phosphates contained in urine passed during the 24 hours: multiply the amount found in grammes, by the number of cubic centimetres of urine

passed in 24 hours, and divide the result by 50. (A gramme in weight corresponds to a cubic centimeter in volume.)

SULPHATES.

The presence of sulphates in the urine is recognized by first adding to 4 grammes of urine in a test tube, several drops of hydrochloric acid. Into this mixture allow a drop or two of a solution of the chloride of barium to trickle; there is formed a white precipitate of barium sulphate, which is insoluble in nitric acid.

COLORING MATTER.

The coloring matter of the urine is called urohaematin. The processes by which its quantity may be estimated, are long and difficult, and do not properly belong in a work of this size.

For such ingredients of the urine as Hippuric Acid, Inosite, Creatin, Leucin, Tyrosin, Kiestin or Chyle, the student is referred to the larger works; preferably to Beale.

APPENDIX.

FORMULA OF ESBACH :

For solution used in determining the quantity of *urea* present in a given amount of urine.

Distilled water, .	100	cubic centimetres,
Soda-lye, . . .	40	" "
Bromine, . . .	2	" "

ESBACH'S UREOMETER.

A tube, 10 millimetres in diameter and 28 cubic centimetres in capacity, graduated in 160 parts, at intervals of 10.

METRIC SYSTEM.

WEIGHTS AND MEASURES.

A gramme by weight of distilled water occupies a cubic centimetre of volume.

Five grammes correspond to an ordinary teaspoonful.

One gramme by weight corresponds to about *fifteen* grains.

A millimetre is .039 of an inch.